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LIQUID CRYSTAL DISPLAY DEVICE, METHOD OF MANUFACTURING THE SAME AND DEVICE FOR DROPPING LIQUID CRYSTAL

[Abstract]

PROBLEM TO BE SOLVED: To enable the quantity of a liquid crystal dropped in a dropping injection method to be precisely measured and controlled, at the same time to restrain the viscosity of the liquid crystal so as to be low by using a liquid crystal material most suited for the dropping injection method, to accelerate the response speed, especially

halftone response speed and to simply manufacture a liquid crystal display device in an excellent yield.

SOLUTION: A frame pattern is formed by applying a sealing material 21 to the peripheral part of a picture display region provided on one (a substrate 22) out of a pair of substrates. The liquid crystal is dropped inside the frame pattern and the substrates are attached to each other. Aiming at the liquid crystal display device by hardening the sealing material 21, the sealing material 21 is applied so as to position a starting point 31a and an end point 31b of the sealing material application outside the frame pattern.

[Claim(s)]

[Claim 1] A method of manufacturing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the sealing material is applied so as to position a starting point and an end point of the sealing material application outside the frame pattern.

[Claim 2] A method of manufacturing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a

pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein in order to conduct the pair of substrates, ultraviolet rays formed of parallel rays for hardening resin are irradiated in spots onto a transfer seal, formed by incorporating conductive particles into resin, from a vertical direction or sloping direction of the substrate.

[Claim 3] A method of manufacturing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein in order to conduct the pair of substrates, a transfer

seal, formed by incorporating conductive particles into resin, is applied, the transfer seal is hardened by ultraviolet irradiation for attaching the substrates by hardening the resin, and the substrates are thermally treated, being supported in a parallel direction by a support case, after the irradiation of ultraviolet rays.

[Claim 4] A liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the pair of substrates are conducted by a transfer seal formed by incorporating particles coated with a transparent conductive film on the

surface.

[Claim 5] A liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein in order to conduct the pair of substrates, a film for reflecting ultraviolet rays irradiated for hardening the resin is formed as an electrode on a lower part of a transfer seal.

[Claim 6] A method of manufacturing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a

pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein a liquid crystal orientation film is formed on the region where the ends thereof become an outer side of an inner circumferential side of the sealing material and an inner side of an outer circumferential side of the sealing material, light having a wavelength of about 300 to 500nm is irradiated, and the sealing material is hardened.

[Claim 7] A device for dropping liquid crystal comprising: a dispenser means for discharging a predetermine amount of liquid crystal; and a measuring means for measuring the amount of liquid crystal discharged by the dispenser means, the measuring means having an optical sensor, integrating a change in signals of the corresponding

optical sensor generated when liquid discharged from the dispenser means passes through the optical sensor, and measuring the amount of liquid crystal discharged.

[Claim 8] A device for dropping liquid crystal, comprising: a dispenser means for recognizing a drop shape of liquid crystal discharged by the dispenser means and estimating the discharge amount of liquid crystal of the sealing material based on the corresponding shape.

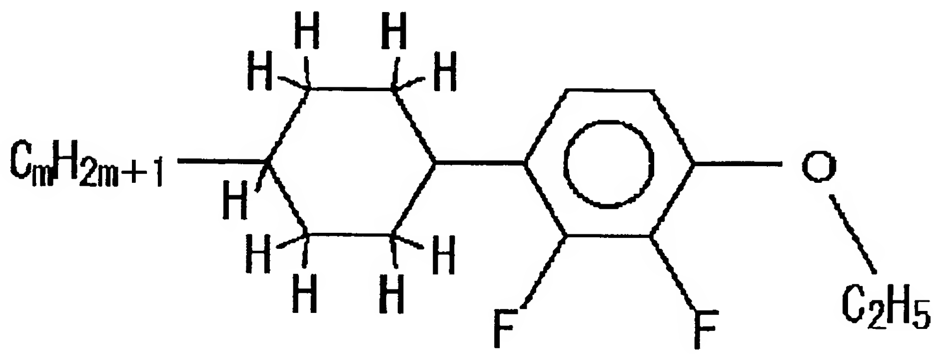
[Claim 9] A device for dropping liquid crystal, comprising: a discharge means having a plurality of thin tubes and for discharging a predetermined amount of liquid crystal from the respective thin tubes; and a measuring means having respective backing plates corresponding to the respective thin tubes and for measuring the weight of drops of

liquid crystals received on the respective backing plates, wherein the drops of liquid crystal, the weight of which is measured by the measuring means and the discharge amount thereof is specified, are supplied from the respective backing plates.

[Claim 10] A device for dropping liquid crystal in a vertical orientation, which has a pair of substrates, at least one of which being transparent, a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region, liquid crystal whose dielectric isotropy is negative is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the liquid crystal material comprises a liquid crystal compound expressed by the following general formula and the number m

of carbon atoms of the end alkyl group thereof is greater than two.

[Chemical Formula 1]



[Claim 11] A device for dropping liquid crystal in a vertical orientation, which has a pair of substrates, at least one of which being transparent, a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region, liquid crystal, whose dielectric isotropy is negative, is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the liquid crystal material comprises a neutral liquid

crystal compound having no polarity, and the liquid crystal comprising this neutral liquid crystal compound has a high volatility with which the weight ratio decreases by 1% or more in a vacuum state when dropped, and has a rotational viscosity lower by 15% or more as compared to the nonvolatile neutral liquid crystal compound.

[Title of the Invention] LIQUID CRYSTAL DISPLAY DEVICE, METHOD OF MANUFACTURING THE SAME AND DEVICE FOR DROPPING LIQUID CRYSTAL

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a liquid crystal display device which is formed by dropping liquid crystal inside a frame pattern having ultraviolet curing resin or ultraviolet plus thermosetting resin formed on substrates, attaching the upper and lower substrates, and hardening the resin, a method of manufacturing the same, and a device for dropping liquid crystal for implementing the aforementioned drop injection method.

[0002]

[Description of the Prior Art] Conventionally, in the manufacture of a liquid crystal display panel, a method of injecting from an injection port formed a sealed cell into a corresponding panel has been utilized in a liquid crystal injection process. In recent years, there is an increasing demand for a large-sized screen of a liquid crystal display panel, and it is becoming difficult to attain sufficient display characteristics by this method.

[0003] Therefore, attention is focused on a dropping injection method in which an frame pattern is formed by applying a sealing material made of ultraviolet curing resin or (ultraviolet plus thermo) setting resin on the peripheral part of a picture display region of a cell substrate and each

substrate is attached by dropping liquid crystal in the frame pattern. This dropping injection method can greatly reduce the time of a panelization process including a liquid crystal injection process step and simplify the same, and enables it to manufacture a liquid crystal display panel with a high reliability at a low cost. At the same time, a liquid crystal display panel manufactured by using the corresponding dropping injection method has a very high contrast ratio at the front, has excellent visual characteristics, and has superiority in that it has a good halftone response. Thus, the liquid crystal display panel is preferably adapted to a big screen liquid crystal monitor of high performance.

[0004]

[Problem(s) to be Solved by the Invention] The liquid crystal injection according to the above dropping injection method is very excellent from a viewpoint of a manufacturing process and from a viewpoint of the display characteristics of a product, while there are several problems to be solved to be described hereinafter.

[0005] – Problem about sealing material – (1): Referring to FIG.23, in the dropping injection method, since no injection port is required for a cell (substrate 101), a main seal 102 becomes a closed frame pattern. But, if a frame pattern is formed by using a dispenser, the starting point and end point of sealing material application are overlapped, and a seal width at the part 103 becomes larger. A shielding film 105 is formed n the peripheral part of a display region. If the weal width becomes larger, parts

of the sealing material are shaded to thus cause a defective setting (FIG.23(a)). Thus, in the prior art, there has been proposed a method in which the main seal 102 is kept enough from the shielding film so that the sealing material may not be shaded or a method in which corner portions with a large margin are used as the starting point and end point of sealing material application (Japanese Laid-Open Patent HEI 8-240807). (FIG.23(b)).

[0006] However, if the main seal 102 is kept enough from the shielding film so that the sealing material may not be shaded, the ratio of outer dimensions relative to the image display region 104 becomes greater. Further, if the corners portions are used as the starting point and end point of sealing material application, it becomes more difficult for the

sealing material to be stopped by the shielding film than a straight portion. But, this is because the distance between the shielding film and the sealing material is about 1.4 times greater than the straight portion, and if a swelling portion of an overlapping portion 103 becomes larger than the distance, it is stopped by the shielding film, thereby causing a likewise defective setting.

[0007] (2): Referring to FIG.24, conductive particles 108 are incorporated into a transfer seal 106 during sealing material application to attain a conduction between upper and lower substrates, and the transfer seal 106 is formed at a position where it is inserted into upper and lower transparent electrodes 107. Conventionally, resin particles having nickel or gold with low resistance coated on the surface are used as the

conductive particles 108.

[0008] When resin particles having nickel or gold with low resistance coated on the surface are incorporated into the transfer seal 106, ultraviolet rays are absorbed or reflected, thereby making it difficult for the ultraviolet rays to reach inside the seal. Further, since the transfer seal 102 is inserted into the transparent electrodes 107, the ultraviolet rays are attenuated by the transparent electrodes 107. In a case where the amount of light for hardening the sealing material and the amount of light for deteriorating liquid crystal are close, if ultraviolet rays are collectively irradiated to the main seal 102 and the transfer seal 106 in consideration of attenuating by the transparent electrodes 107, liquid crystal adjacent to the main seal 102 with no transparent electrode 107 is deteriorated,

thereby degrading the retention.

[0009] (3): Referring to FIG.25, in order to improve curing rate in a case where the sealing material is an ultraviolet curing resin and in order to perform thermosetting in a case where the sealing material is a (ultraviolet plus thermo) setting resin, the isotropic treatment and thermal treatment of liquid crystal are simultaneously performed after the irradiation of ultraviolet rays. In dropping injection, the process until ultraviolet irradiation is done on a sheet basis, and a thermal treatment process requiring time is done in a batch fashion. Thus, a substrate is held in a carrier cassette 108, and it is put in a thermosetting furnace and undergoes thermal treatment.

[0010] The carrier cassette 108 is constructed in a structure of

supporting a substrate 101 from the end of the substrate so that the carrier arm may put in and take out the substrate 101. Therefore, the carrier cassette 108 cannot support the substrate 101 in parallel, but the substrate 101 is bent. Though there is no problem if the sealing material is completely hardened only by ultraviolet irradiation, in most cases, it is completely hardened by thermal treatment. Thus, the substrate supporting force is still weak at an initial stage of thermal treatment, and a deviation in position is generated by the effect of bending.

[0011] (4): Referring to FIGs.26 to 28, in a case where hardening resin is hardened by ultraviolet curing resin or (ultraviolet plus thermal) setting resin, ultraviolet rays are generally irradiated from a UV lamp 113 by making the regions excepting the corresponding resin with a shading

mask 112 (FIG.26(a)). At this time, in order for liquid crystal not to be exposed to ultraviolet rays through the substrate, position alignment is performed so that the surfaces of the corresponding resin and the mask end may be almost the same (FIG.26(b)). However, the application width of the corresponding resin has a margin of error of ±0.2mm unless it is strictly managed. Thus, in order that the resin and the shading mask are not overlapped, the resin end and the mask end should have a margin of dimension of this range. When ultraviolet rays are irradiated to this margin region, liquid crystal causes photolysis, thereby degrading the voltage retention.

[0012] To cope with this problem, Japanese Laid-Open Patent HEI 2-308221 proposes a method of irradiating ultraviolet rays by forming a

ultraviolet shielding layer on the surface of a substrate excluding a seal portion, Japanese Laid-Open Patent HEI 8-101395 proposes a method of irradiating ultraviolet rays through a mask having a predetermined pattern and a filter for screening ultraviolet rays of shorter than a specific wavelength (FIG.27), and Japanese Laid-Open Patent HEI 10-221700 proposes a method of irradiating ultraviolet rays by forming a bandpass filter for screening ultraviolet rays on the outer side of a display region.

[0013] Liquid crystal photolysis mostly occurs in a short wavelength of less than 320nm, thus the liquid crystal photolysis is restricted to the minimum if the corresponding resin is hardened by irradiating wavelengths longer than the above wavelength. But, wavelengths of 300nm to 320nm are also required for the hardening of ultraviolet curing

resin, and if the resin is hardened with a wavelength longer than the above wavelengths, the reaction rate is lowered. If the reaction rate is lowered, unhardened components of the resin are melted in the liquid crystal during heat treatment, thereby contaminating the liquid crystal.

[0014] Further, it is also possible to select ultraviolet curing resin for performing the equivalent polymerization only with a wavelength in which liquid crystal photolysis does not occur, that is, a long wavelength of longer than 320nm. However, the options of resin material are quite narrow, and the reliability is lower than prior art resin when considering the staining property, application stability and hardening physical property of resin material relative to liquid crystal.

[0015] An ultraviolet shielding layer disclosed in Japanese Laid Open

Patent Publication HEI 2-308221 is a filter for shielding almost all ultraviolet rays in order to prevent liquid crystal photolysis, and suppresses the transmittance of a wavelength from 300nm to 320nm to a considerably low level (several % ~ 10%). Therefore, when the seal portion and the ultraviolet shielding layer are overlapped, the reaction rate of resin is lowered at that portion, and unhardened components of resin are melted in the liquid crystal during thermal treatment, thereby contaminating the liquid crystal.

[0016] A filter disclosed in Japanese Laid Open Patent Publication HEI 8-101395 is a filter for blocking ultraviolet rays of shorter than a specific wavelength harmful to liquid crystal in order to prevent liquid crystal photolysis, and suppresses the transmittance of a wavelength from

300nm to 320nm to a considerably low level (FIG.28). Therefore, when resin is hardened through the filter, the reaction rate of resin is lowered at that portion, and unhardened components of resin are melted in the liquid crystal during thermal treatment, thereby contaminating the liquid crystal.

[0017] A bandpass filter disclosed in Japanese Laid Open Patent Publication HEI 10-221700 is a filter for blocking short wavelengths harmful to liquid crystal and long wavelengths which is a heat source in order to prevent liquid crystal photolysis, and suppresses the transmittance of a wavelength from 300nm to 320nm to a considerably low level(10 ~ 20%). Therefore, when the seal portion and the ultraviolet shielding layer are overlapped, the reaction rate of resin is lowered at that portion, and unhardened components of resin are melted in the liquid

crystal during thermal treatment, thereby contaminating the liquid crystal.

[0018] – problem about control of liquid crystal dropping amount – In the dropping injection method, when dropping using a dispenser means, the accuracy of the thickness of a cell of a substrate is determined according to the amount of liquid crystal dropped. Thus, the dropping amount should be measured accurately. However, in the prior art method, no matter how accurate the accuracy of control increases, this cannot avoid liquid from remaining in a needle of the dispenser means, and it is not clear if the actual dropping amount is consistent with a predetermined dropping amount, and it is often the case that both of them are different. In this case, though there is a method of measuring a liquid dropping amount by measuring the weight of liquid crystal dropped on each

individual substrate, this method is very difficult to use in the present day, when a large-sized screen of a liquid crystal display panel is demanded.

[0019] – problem about liquid crystal material – At present, a liquid crystal dropping device has to be improved in display characteristics, and has to be manufactured at a low cost. Thus, as described above, a dropping injection method is efficient for a low cost manufacture, by which a panelization process can be greatly simplified. However, in the dropping injection method, a method of injecting liquid crystal material and a method of attaching a pair of substrates are totally different from the prior art method. Thus, liquid crystal material must have a strong resistance, and be suitable for the dropping injection method.

[0020] Since ultraviolet rays (UV) are used for actual hardening in the

dropping injection method, liquid crystal material having a strong resistance to UV is required. Further, liquid crystal material may be in contact with the seal not hardened enough, the liquid crystal material must be strongly resistant to contamination.

[0021] By the way, liquid crystal material whose dielectric isotropy is negative is used for a liquid crystal dropping device in a vertical orientation. Generally, liquid crystal material whose dielectric isotropy is negative may be restricted by the type of a liquid crystal compound comprising the liquid crystal material. Widely used liquid crystal compounds at present are classified into three types. By selecting any better liquid crystal material among those liquid crystal compounds, the yield is increased, display non-uniformity and residual images are

suppressed, and the life span of the product is lengthened.

[0022] As one of the causes of display non-uniformity and defective products, electric properties in a liquid crystal display panel are strongly involved. There is a need to increase the voltage retention of a liquid crystal cell, lower the ion density, and lower a residual DC voltage. As liquid crystal material, one having a high purity and a high specific resistance of bulk liquid crystal has to be used.

[0023] As a result of investigation of negative liquid crystal, it can be seen that negative liquid crystal includes ones capable of maintaining a high bulk specific resistance and ones to be deteriorated, and they depend upon negative liquid crystal compounds. Further, because liquid crystal whose dielectric isotropy is negative is insufficient in kind, it must

be avoided to use only one of the above three types. To satisfy the electro-optic property of a liquid crystal dropping device, liquid crystal physical properties have to be offered, and the above three types have to be used together.

[0024] Besides, even if the resistance of liquid crystal is increased, the viscosity of the liquid crystal is increased, thereby lowering the response speed of a liquid crystal dropping device. According to the theory about response of liquid crystal, the response speed is considered to be proportional to the viscosity of liquid crystal, thus it is preferable to use liquid crystal material of a lower viscosity.

[0025] As explained above, the dropping injection method is a technique which contributes to the efficient manufacture of a liquid

crystal display panel and the realization of excellent display characteristics, but there are a lot of problems to be overcome, and it is expected that they are to be overcome later.

[0026] The present invention is directed to solve the above problems, and provides a liquid crystal display device, a method of manufacturing the same and a device for dropping liquid crystal which attain the following objects.

[0027] (1) It is an object of the present invention to restrain display non-uniformity caused from a decrease of retention, which may easily occur due to a sealing material, manufacture a liquid crystal dropping device conveniently at a high yield by using a dropping injection method, and realizes a liquid crystal dropping device having a high reliability.

[0028] (2) It is another object of the present invention to realize a device for dropping liquid crystal which performs a liquid crystal dropping injection having a good yield and a high reliability by enabling the quantity of a liquid crystal dropped in a dropping injection method to be precisely measured and controlled and making the cell thickness uniform by properly controlling the quantity of a liquid crystal for each dropping region.

[0029] (3) It is another object of the present invention to realize a liquid crystal display device which restrains the viscosity of the liquid crystal so as to be low by using a liquid crystal material most suited for the dropping injection method, accelerates the response speed, especially halftone response speed and improves display properties further more.

[0030]

[Means for Solving the Problem] The present inventors have devised several embodiments as follows as a result of assiduous investigation.

[0031] There is provided a liquid crystal display device and a method of manufacturing the same according to the present invention aiming at providing a liquid crystal display device , in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the sealing material is applied so as to position a starting point and an end point of the sealing material application outside the frame pattern. By this,

the starting point and the end point on the frame pattern do not overlap, thus it can avoid the width of the sealing material from increasing and overlapping with a shielding film on the frame pattern.

[0032] In this case, it is preferable that the sealing material is coated so as to position at least one of the starting point and the end point on an unmounted side of the substrate. When the corresponding point is formed so as to be positioned outside the frame pattern, a link pattern for linking to the frame pattern is required. Cut positions of the substrate on a mounted side are different at upper and lower sides. Thus, if the corresponding point is positioned on the mounted side, respective substrates of a cut portion are attached by the link pattern, thereby making it difficult to cut them. In case of the unmounted side, the cut

position of the substrates are the same at upper and lower sides, thus respective substrates of a cut portion are not attached by the link pattern, and the substrate can be easily cut.

[0033] Further, it is preferable that at least one of the starting point and the end point is linked with the frame pattern so as to intersect the unmounted side. Although the corresponding point and the frame pattern may be linked in such a fashion not to intersect the unmounted side by forming the link pattern on a slant, it is difficult and not realistic to apply a seal in a sloping direction from the viewpoint of the control of a dispenser means. If the corresponding point and the frame pattern are linked in such a fashion to intersect the unmounted side, the link pattern can be formed on a straight line, thereby making the seal application easier.

[0034] Further, it is preferable that a seal pattern is continuously formed by using the sealing material by making the starting point and the end point consistent with each other on the substrates. If the seal pattern is continuously formed by the technique of single line drawing, the starting point and the end point can be eliminated from the frame pattern, and the seal can be easily applied even on a multifaced substrate.

[0035] There is provided a liquid crystal display device and a method of manufacturing the same according to the present invention aiming at providing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are

attached to each other, and the sealing material is hardened, wherein the pair of substrates are conducted by a transfer seal formed by incorporating particles coated with a transparent conductive film on the surface.

[0036] Among transparent conductive films, for example, an ITO film has a higher resistance than nickel or gold that has been used as a prior art conductive film, but is being widely used for a liquid crystal display panel as a transparent electrode and does not have a problem in conduction. Though ultraviolet rays are partially absorbed by the ITO film and attenuated, this film has the highest transmittance among metal layers. By incorporating this film in the transfer seal, it becomes easier for ultraviolet rays to reach into the seal, and accordingly it becomes easier

to harden the transfer seal.

[0037] There is provided a liquid crystal display device and a method of manufacturing the same according to the present invention aiming at providing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein a film for reflecting ultraviolet rays irradiated for hardening the resin is formed as an electrode on a lower part of a transfer seal for conducting the pair of substrates.

[0038] By this, some parts of the ultraviolet rays irradiated to the

transfer seal are reusable, thereby suppressing the amount of light for hardening the transfer seal to a low level compared to the prior art.

[0039] In this case, it is preferable that an aluminum film or silver film is used as the film for reflecting ultraviolet rays and formed on the substrate at a thin film transistor side. Since the aluminum film or silver film is a metal film which reflects ultraviolet rays and widely used for a TFT process, it is possible to form a reflective film without increasing a number of processes.

[0040] There is provided a method of manufacturing a liquid crystal display device according to the present invention aiming at providing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display

region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein in order to conduct the pair of substrates, ultraviolet rays formed of parallel rays for hardening resin are spot irradiated onto a transfer seal, formed by incorporating conductive particles into resin, from a vertical direction or sloping direction of the substrate.

[0041] In the spot irradiation, parallel light having high straightforwardness can be irradiated by using a light guide of quartz fiber or the like. Since conductive particles for absorbing and reflecting some or entire parts of ultraviolet rays are incorporated into the transfer seal, the ultraviolet rays reaching into the transfer seal are attenuated by these

particles. Further, the transfer seal is fitted into the transparent electrode, and accordingly ultraviolet rays are attenuated. When ultraviolet rays formed of parallel rays are spot irradiated onto a transfer seal from a vertical direction or sloping direction of the substrate, as much additional ultraviolet rays as they are attenuated can be irradiated. Further, because parallel light can be irradiated, it is possible to restrain liquid crystal from being degraded by incoming light to the minimum degree.

[0042] There is provided a method of manufacturing the same according to the present invention aiming at providing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame

pattern and the substrates are attached to each other, and the sealing material is hardened, wherein in order to conduct the pair of substrates, a transfer seal, formed by incorporating conductive particles into resin, is applied, the transfer seal is hardened by ultraviolet irradiation for attaching the substrates by hardening the resin, and the substrates are thermally treated, being supported in parallel by a support case, after the irradiation of ultraviolet rays.

[0043] By supporting the substrates in parallel and thermosetting them not by a prior art carrier cassette for supporting the substrates from the ends of the substrates but by a carrier cassette or parallel flat plate of such a structure supporting the substrates in parallel by multipoint supporting the substrates surfaces, the creation of misalignment during

thermosetting treatment is restrained.

[0044] There is provided a method of manufacturing the same according to the present invention aiming at providing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein a liquid crystal orientation film is formed on the region where the ends thereof become an outer side of an inner circumferential side of the sealing material and an inner side of an outer circumferential side of the sealing material, light having a wavelength of about 300 to 500nm is irradiated, and the sealing material is hardened.

[0045] Liquid crystal photolysis mostly occurs in a short wavelength of less than 320nm, and wavelengths of 300nm to 320nm are also required for the hardening of ultraviolet curing resin. Thus, an invention of irradiating these wavelengths not to liquid crystal but to the corresponding resin is required. However, this is not preferable because it is difficult to realize this idea and the aforementioned problems occur even if every liquid crystal display panel is positioned using a blocking filter for a mask. Therefore, an invention of attenuating wavelengths of 300nm to 320nm within the range of not lowering the reaction rate of the corresponding resin that much and restraining liquid crystal photolysis to the minimum level is devised.

[0046] The reaction rate of resin was measured by irradiating ultraviolet

rays of the amount of light for hardening the corresponding resin using edge filters having a different transmittance of 300nm to 320nm. As a result, although there may be some difference according to the type of resin, it can be seen that if the transmittance of the wavelength is about 30%, the reaction rate is not lowered in most cases, when viewed from a 313nm emission line peak of a high pressure mercury lamp. This is because while the amount of light for hardening is an amount of ultraviolet light at which the reaction rate of the corresponding resin almost reaches saturation, the hardening reaction of the corresponding resin rapidly increases about 30% of the amount of light for hardening, and the reaction rate does not change much afterwards.

[0047] However, when ultraviolet rays of the same amount are

irradiated to liquid crystal using these filters, liquid crystal photolysis is still large, and display defectiveness is generated by the deterioration of retention. Therefore, long wavelengths longer than 500nm less affected by the hardening of the corresponding resin are cut and ultraviolet rays of the same amount are irradiated to liquid crystal. AS a result, liquid crystal photolysis becomes smaller, and no display defectiveness caused from the deterioration of retention is generated. This is because although no liquid crystal photolysis does not occur only by a long wavelength longer than 500nm, a long wave length longer than 500nm becomes a heat source by being combined with a wavelength of 300nm to 320nm, and liquid crystal photolysis is accelerated.

[0048] The ends of the orientation film are formed on the region where

the ends thereof become an outer side of an inner circumferential side of the corresponding resin and an inner side of an outer circumferential side of the corresponding resin because the orientation film has the function of absorbing unhardened components of the corresponding resin and restraining them from being diffused in the liquid crystal. Further, if the ends of the orientation film are formed to have the same surface as the inner circumferential side of the corresponding resin, a gap is generated between the ends of the orientation film and the corresponding resin due to misalignment. If the ends of the orientation film are formed on the outer side of the outer circumferential side of the corresponding resin, the corresponding resin and the substrate are attached with the orientation film having weak moisture resistance therebetween, whereby the

attaching strength is sharply lowered under a high temperature and a high humidity. Further, the orientation film can be used as a filter for alleviating liquid crystal photolysis since the orientation film attenuates a wavelength of 313nm emission line peak by 1.5%. By this, the transmittance of the corresponding wavelength of the filter used for an irradiation light source can be increased, thus the corresponding resin of the outer side of the ends of the orientation film can be hardened more firmly.

[0049] Accordingly, liquid crystal photolysis can be restrained by combining the above methods without deteriorating the reaction rate of the corresponding resin that much, thereby preventing display defectiveness caused from the deterioration of retention.

[0050] In this case, it is preferable that the ends of the orientation film

on the substrate where at least a color filter is formed are formed on the region where the ends thereof become an outer side of an inner circumferential side of the sealing material and an inner side of an outer circumferential side of the sealing material, light having the above wavelength is irradiated from the corresponding substrate side, and the sealing material is hardened.

[0051] This color filter serves as a mask of a picture display region. If the ends of the orientation film on the substrate is formed on the corresponding region, and light is irradiated from the corresponding substrate, there is no need to mask the regions other than the resin region.

[0052] Furthermore, it is preferable that the transparent electrode and

the ends of the orientation film on the substrate where at least a color filter is formed are formed on the region where the ends thereof become an outer side of an inner circumferential side of the sealing material and an inner side of an outer circumferential side of the sealing material, light having the above wavelength is irradiated from the corresponding substrate side, and the sealing material is hardened.

[0053] The transparent electrode film is used as a filter for alleviating liquid crystal photolysis since it attenuates the wavelength of 313nm emission line peak by 35% and attenuates the wavelength by 45% by being used in combination with the orientation film. By this, the transmittance of the corresponding wavelength of the filter used for an irradiation light source can be increased still more, thus the

corresponding resin of the outer side of the transparent electrode and the end of the orientation film can be hardened more firmly.

[0054] Furthermore, it is preferable that a filter for blocking almost all wavelengths except for the corresponding wavelength is arranged at an irradiation light source side as a means for irradiating light having a wavelength of about 300 to 500nm.

[0055] In the aforementioned example, a filter for blocking ultraviolet rays of less than a specific wavelength harmful to liquid crystal is arranged between a mask and a liquid crystal display panel. By arranging the filter of the present invention by this arrangement, the long wavelength blocking filter generates heat since it absorbs a long wavelength of greater than 500nm, and the liquid crystal display panel is

also heated. When a wavelength of 300 to 320nm is irradiated with the liquid crystal display panel heated, liquid crystal photolysis reaction is stimulated as described above. Thus, the flow of heat relative to the liquid crystal display panel is prevented by arranging the long wavelength blocking filter on the irradiation light source side. Further, it is often the case that a short wavelength blocking filter may also absorb on a long wavelength side as well as a short wavelength side, and the short wavelength blocking filter is arranged on the irradiation light source side, thereby restraining the flow of heat relative to the liquid crystal display panel.

[0056] Further, the amount of light for hardening the sealing material is preferably less than about 3000 mJ/cm^2 relative to line I.

[0057] The amount of light for hardening the corresponding resin is set based on the cumulative amount of light in a wavelength band (of about 350nm ± 30nm) near a 365 emission line (line I) peak at which the irradiation strength of a high pressure mercury lamp becomes maximum. If the strength of the peak of line I is set to 100, the 313nm emission line peak becomes about 60 in case of a high pressure mercury lamp and about 30 in case of a metal halide lamp. But, since the high pressure mercury lamp has high strength only at the emission line peak, while the metal halide lamp becomes broad near the emission line peak, both lamps do not show a big difference in cumulative amount of light of a wavelength of 300 to 320nm.

[0058] Light having a wavelength of about 300 to 500nm is irradiated to

liquid crystal, to thus prevent the lowering of the amount of ultraviolet light at which liquid crystal photolysis is activated. The transmittance of the blocking filter used shows 50% at a 313nm emission line peak and 90% at a 365nm emission line peak. As a result, though different a little according to the type of liquid crystal, the cumulative amount of light in a wavelength band (of about 350nm ± 30nm) near a 365 emission line (line I) peak is about 1000 mJ/cm^2. In the present invention, a wavelength of 300 to 320nm can be attenuated by 15% by using the orientation film. But, in case of surface-irradiating ultraviolet rays to a large-sized substrate, if the guaranteed figures of the illuminance non-unifomity is generally ±15%, and the amount of light for hardening the corresponding resin is about 3000 mJ/cm^2 relative to line I, the maximum value portion of the non-

uniformity exceeds this value and ultraviolet rays are irradiated to liquid crystal, thereby activating liquid crystal photolysis and lowering the retention. In order to activate the reaction, energy of greater than a predetermined quantity is required. If the energy exceeding the predetermined quantity is applied, the reaction is accelerated, or if the quantity of energy is less than the predetermined quantity, the reaction is not activated, making the reaction sluggish.

[0059] There is provided a device for dropping liquid crystal according to the present invention, comprising: a dispenser means for discharging a predetermine amount of liquid crystal; and a measuring means for measuring the amount of liquid crystal discharged by the dispenser means, the measuring means having an optical sensor, integrating a

change in signals of the corresponding optical sensor generated when liquid discharged from the dispenser means passes through the optical sensor, and measuring the amount of liquid crystal discharged.

[0060] The amount of liquid crystal discharged from the dispenser means is low in accuracy if there is merely the self control of the corresponding dispenser means, and thus the measuring means is disposed to measure the amount (volume) of corresponding liquid crystal by injecting liquid crystal discharged from the dispenser by the optical sensor. In this case, the output of the optical sensor shows a measured width of drops of the discharge liquid crystal. If continuously measured, a time change in discharge amount is measured, and if the measurement result is integrated, the value equivalent to the total amount of discharge

can be obtained. By measuring and this value and the discharge amount of the sealing material and comparing them with each other, the correlation is obtained in advance. Based on the corresponding correlation, the discharge amount of the sealing material can be estimated in real time. By this, the total discharge amount to be dropped on a desired region can be accurately controlled, and even when manufacturing a large screen liquid crystal panel, the uniformity of a cell thickness can be attained.

[0061] In this case, as a concrete example, it is preferable that the measuring means measures the discharge amount of liquid crystal in a manner that laser light is irradiated in a direction almost perpendicular to discharge liquid crystal, and the output of the laser light is changed by the

discharge liquid crystal intersecting this laser light to detect it by the optical sensor. In this way, by using a laser as an irradiation light source, the discharge amount of liquid crystal can be measured more rapidly and accurately.

[0062] Furthermore, it is preferable that the discharge amount of liquid crystal is measured in at least two directions or the corresponding discharge amount is measured in two directions orthogonal to each other since the accuracy of the measurement of discharge amount can be attained.

[0063] Furthermore, it is preferable that the optical sensor is disposed at a position within 2cm from a liquid crystal discharge port of the dispenser means.

[0064] As a result of measuring the amount of liquid crystal dropped onto the sealing material by disposing the optical sensor on the liquid crystal discharge port of the needle of the dispenser means, it is seen that in most cases, since liquid drops are continuously dropped about 2cm from the liquid crystal discharge port, the discharge amount of liquid crystal is most preferably 1cm. This is because, if the discharge distance is increased to about 2cm or more by a pressure difference between the inner side and outer side of the inside of the needle or by the generation of bubbles, liquid crystal that has been continuously discharge at first becomes discontinuous, thereby reducing the accuracy of measurement.

[0065] There is provided a device for dropping liquid crystal according to the present invention, comprising: a dispenser means for recognizing a

drop shape of liquid crystal discharged by the dispenser means and estimating the discharge amount of liquid crystal of the sealing material based on the corresponding shape.

[0066] The amount of liquid crystal discharged from the dispenser means is low in accuracy if there is merely the self control of the corresponding dispenser means, and thus the measuring means is disposed to recognize a drop shape of liquid crystal discharged from the dispenser means and estimate the discharge amount of liquid crystal of the sealing material based on the corresponding shape. In this case, the correlation between the drop shape of liquid crystal and the amount (volume) thereof is obtained in advance, and the discharge amount of the sealing material is estimated based on them. By this, the total discharge

amount to be dropped on a desired region can be accurately controlled, and even when manufacturing a large screen liquid crystal panel, the uniformity of a cell thickness can be attained.

[0067] In this case, as a concrete example, the measuring means optically recognizes the drop shape of liquid crystal, and estimates the discharge amount of liquid crystal of the sealing material from an image of the corresponding shape.

[0068] Furthermore, the optical sensor may be disposed near a liquid crystal discharge port of the dispenser means to thus estimate the discharge amount of liquid crystal of the sealing material from the image of the drop shape of liquid crystal by using as a trigger signal a signal of the corresponding optical sensor generated when discharged liquid

crystal passes through the optical sensor.

[0069] Furthermore, the dispenser means may be constructed in a manner that liquid crystal is discharged by moving a piston in a syringe, the discharge amount is controlled according to a stroke of the piston, and the stroke of the piston is automatically changed based on the result of the image processing.

[0070] By this, an estimated value of the discharge amount from the dispenser means measured by the measuring means is feedbacked to the dispenser means, thereby enabling an accurate control of the discharge amount of liquid crystal.

[0071] There is provided a device for dropping liquid crystal according to the present invention, comprising: a discharge means having a plurality

of thin tubes and for discharging a predetermined amount of liquid crystal from the respective thin tubes; and a measuring means having respective backing plates corresponding to the respective thin tubes and for measuring the weight of drops of liquid crystals received on the respective backing plates, wherein the drops of liquid crystal, the weight of which is measured by the measuring means and the discharge amount thereof is specified, are supplied from the respective backing plates.

[0072] The amount of liquid crystal discharged from the discharge means is low in accuracy if there is merely the self control of the corresponding discharge means, and thus the measuring means is disposed to receive drops discharged from the respective thin tubes on the backing plates, measure the weight of the drops, and supply the drops

from the corresponding backing plates. At this time, the amount of drops remaining on the backing plates is measured in advance, and the amount supplied is controlled based on the amount of remaining drops. By this, the total discharge amount to be dropped on a desired region can be accurately controlled, and even when manufacturing a large screen liquid crystal panel, the uniformity of a cell thickness can be attained.

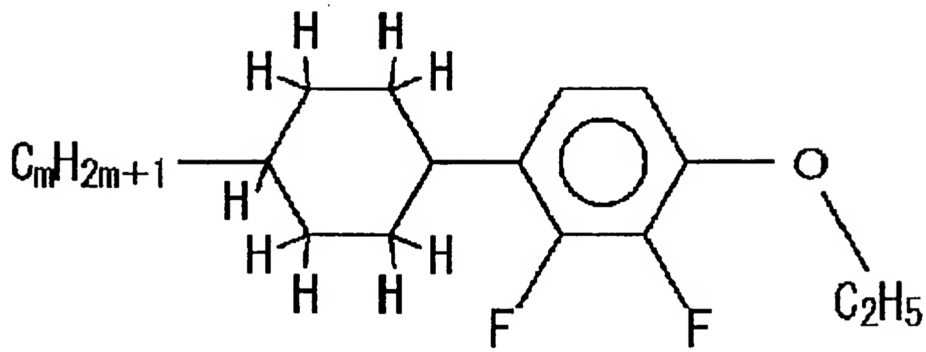
[0073] In this case, it is preferable that water repellent finishing for splashing liquid crystal on a liquid crystal contact region of the measuring means is performed. By this, the remaining of liquid crystal is prevented as much as possible, and a still more accurate amount of liquid crystal can be supplied.

[0074] There is provided a liquid crystal display device and a method of

manufacturing the same according to the present invention aiming at providing a device for dropping liquid crystal of a vertical orientation, which has a pair of substrates, at least one of which being transparent, a frame pattern is formed by applying a sealing material 21 to the peripheral part of a picture display region, liquid crystal whose dielectric isotropy is negative is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the liquid crystal material comprises a liquid crystal compound expressed by the following general formula and the number m of carbon atoms of the end alkyl group thereof is greater than two.

[0075]

[Chemical Formula 2]



[0076] If the liquid crystal comprising a liquid crystal compound expressed by the following formula and having a number m of carbon atoms of the end alkyl group thereof being an even number is used, the specific resistance of bulk liquid crystal can be kept high. The liquid crystal comprising a neutral component having no polar group and having a number m of the general formula of an even number can obtain a good result in all of initial specific resistance, specific resistance after being left under a high temperature, and specific resistance after being exposed to ultraviolet rays (UV), as compared to liquid crystal comprising the same

component and having a number m of an odd number.

[0077] Furthermore, it is preferable that the liquid crystal is restricted to the liquid crystal compounds of the general formula having a number m of 2 and 4. Generally, if the end alkyl group of a liquid crystal compound is lengthened, the liquid crystal display device is directed in a non-preferable way, including an increase of the viscosity of liquid crystal. The liquid crystal compound of the general formula functions to keep a wide nematic phase even when the temperature range of a mixed liquid crystal is at a low temperature side. In this case, it is preferred to include more than two kinds of compounds having a different number m. Therefore, in order to restrain an increase of the viscosity of liquid crystal, it is preferable to use compounds having a number m of 2 and 4.

[0078] There is provided a liquid crystal display device and a method of manufacturing the same according to the present invention aiming at providing a liquid crystal device of a vertical orientation, which has a pair of substrates, at least one of which being transparent, a frame pattern is formed by applying a sealing material 21 to the peripheral part of a picture display region, liquid crystal whose dielectric isotropy is negative is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the liquid crystal material comprises a neutral liquid crystal compound having no polarity, and the liquid crystal comprising this neutral liquid crystal compound has a high volatility with which the weight ratio decreases by 1% or more in a vacuum state when dropped, and has a rotational viscosity lower by 15%

or more as compared to the nonvolatile neutral liquid crystal compound.

[0079] As for the rotational viscosity, the viscosity of liquid crystal can get smaller by 15% or more than that before introduction by introducing a low viscous material. The volatility of the liquid crystal at this time shows a decrease (volatilization) of more than 1% in the weight ratio. In this way, the response speed of the liquid crystal display device can be improved by making the liquid crystal material have a low viscosity.

[0080] In this case, it is preferable the liquid crystal material has a transparent point of more than 70□, satisfies the dielectric isotropy $\Delta\varepsilon$ of $-4.0 \leq \Delta\varepsilon < 0$, and has a refractive index isotropy Δn of more than 0.1000. By satisfying this condition, display characteristics, such as luminance (transmittance), response speed and so on, or mass productivity can be

improved.

[0081] Moreover, such a liquid crystal display device preferably has a multi-domain structure in which its liquid crystal molecules are aligned in more than two directions. By this, the viewing angle property can be improved, and the liquid crystal display device is made suitable for use in a liquid crystal monitor or the like.

[0082]

[0083] [Embodiment of the Invention] Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0084] – General Construction of Liquid Crystal Display Device – FIG.1 is a schematic cross sectional view showing a general main construction

of a liquid crystal display device. This liquid crystal display device includes: a pair of transparent glass substrates 1 and 2 facing each other at a predetermined gap; and a liquid crystal layer 3 caught between these transparent glass substrates 1 and 2.

[0085] An insulating layer 4 is incorporated on a piece of a transparent glass substrate 1 to form a plurality of pixel electrodes 15 and form a transparent orientation film 6a as if covering the pixel electrodes 5, and a color filter 7, a common electrode 8 and an orientation 6b are sequentially laminated on another piece of a transparent glass substrate 2. The orientation films 6a and 6b are faced together so as to catch the liquid crystal layer 5, thereby fixing the glass substrates 1 and 2, and polarizers 9 and 10 are disposed on outer sides of the respective substrates 1 and 2.

The pixel electrodes 5 are formed along with an active matrix, and in an illustrate example, a data bus line 11 of an active matrix is indicated. Further, the electrodes may be only disposed on one of the substrates (For example, in an IPS mode).

[0086] Hereinafter, in the formation of a liquid crystal layer 3 using a dropping injection method, an example of various improvements in structure, in manufacturing process and in the device for dropping liquid crystal is disclosed in several embodiments to be described below.

[0087] In a method of manufacturing a liquid crystal display device commonly used in each individual embodiment, ultraviolet curing resin or (ultraviolet plus thermo) setting resin is used as material of a main seal, a glass substrate A serving as a TFT (thin film transistor) substrate and a

glass substrate B serving as a CF (color filter) substrate are prepared, for example, a frame pattern of the main seal is formed on a picture display region of the glass substrate B by a dispenser, and liquid crystal is dropped inside the frame pattern by a dropping injection method, the substrates A and B are attached to each other, and the main seal is hardened. Thereafter, the attached substrates A and B are cut in the shape of a TFT substrate + a CF substrate, and undergo several subsequent processes, thereby completing a liquid crystal display device.

[0088] (First Embodiment) FIG.2 is a schematic plane view showing the shape of a glass substrate with a frame pattern formed before a liquid crystal injection process is performed by a dropping injection method. In the present example, a link pattern and a frame pattern are formed on the

peripheral part of a display region 23 of a glass substrate 22 side serving as a CF substrate by applying ultraviolet resin (for example, a product of ThreeBond, product name: 30 Y-363) to the main seal 21 by a dispenser. A starting point 31a and an end point 31b of an overlapping portion 31 are disposed at a position where they become an unmounted side or an outer part of the frame pattern, and the link patter is formed so that they are adjacent to each other after they are attached to each other.

[0089] Further, the seal width of the main seal 21 is set to 1mm, and a corner portion has a radius of 1mm so that the line width thereof is the same as a linear portion. The frame pattern is formed so that its inner circumferential side and a shielding film 23 have a gap of 0.5mm therebetween after being attached.

[0090] Next, a required amount of liquid crystal is dropped inside the frame pattern by the liquid crystal dropping method to bond the glass substrate 22 and the glass substrate serving as the TFT substrate in vacuum and drop liquid crystal by opening the atmosphere.

[0091] Ultraviolet rays are collectively irradiated from the glass substrate 22, the seal is hardened by thermal treatment, and cut to a predetermined dimension, thereby obtaining a liquid crystal display panel. Further, as for the cutting of the substrates, the glass substrate 22 serving as the CF substrate is cut along a cut line 32, and the glass substrate serving as the TFT substrate is cut along a cut line 33.

[0092] Here, for comparison with the liquid crystal display device of the present example, a liquid crystal display device as shown in FIG.23 as

comparative examples is manufactured.

[0093] In the comparative example 1, as shown in FIG.23(a), a frame pattern is formed by a main seal 102. A starting point and an end point are disposed at a position on the frame pattern, and the frame pattern is linked between the starting point and the end point (an overlapping portion 103 is formed). Except for this, the comparative example 1 is constructed in the same way as the present example, thereby obtaining a liquid crystal display panel.

[0094] In the comparative example 2, as shown in FIG.23(b), a frame pattern is formed by a main seal 102. A starting point and an end point are disposed at a position on the frame pattern or on the corner portion, and the frame pattern is linked between the starting point and the end point

(an overlapping portion 103 is formed). Further, the corner portion is not formed in an arc shape. Except for this, the comparative example 1 is constructed in the same way as the present example, thereby obtaining a liquid crystal display panel.

[0095] In the present example, since the starting point 31a and the end point 31b are formed outside the frame pattern, the starting point 31a and the end point 31b are not overlapped on the frame pattern, and the main seal 21 of frame pattern linking portion and the shielding film 23 are not overlapped. In contrast, in the comparative examples 1 and 2, since an overlapping portion 103 of the starting point and end point are formed on the frame pattern, the main seal 102 of the frame pattern linking portion is overlapped with the shielding film 105. The seal width of the frame pattern

linking portion of the comparative examples 1 and 2 is 2.6mm, and the seal width of the main seal 102 when applied in a double layer is 2.0mm. This is because the dispenser moves in a vertical direction on the starting point and the end point, thus the seal application amount becomes greater than on the linear portion. The frame pattern linking portion of the comparative example 1 is protruded 0.8mm toward the inner circumferential side, and the gap between the inner circumferential side and the shielding film 105 is 0.5mm, thus the main seal 102 is overlapped with the shielding film 105. In the frame pattern linking portion of the prior art example 2, thought a protrusion amount is 0.8mm which is the same as the comparative example 1, the gap between the inner circumferential side and the shielding film 105 becomes 1.4 times wider. Thus the overlap

between the main seal 102 and the shielding film 105 is small, i.e., 0.1mm. If the gap between the inner circumferential side and the shielding film becomes much wider, the overlap between the main seal 102 and the shielding film 105 can be eliminated, but which is not appropriate because the ratio of outer dimensions to picture display region is increased (the frame becomes wider).

[0096] Furthermore, if the starting point and the end point are separated from the frame pattern, the overlap between the main seal and the shielding film can be eliminated. But, this is not appropriate because the seal width of the frame pattern linking portion becomes smaller, thereby failing to maintain a strength required for the main seal 102.

[0097] The liquid crystal display panels of the present example and the

comparative examples 1 and 2 are provided for a lighting test. As a result, while there occurs no display non-uniformity in the present example, there occurs display non-uniformity from a defective hardening of the main seal 102 in the frame pattern linking portion in the comparative examples 1 and 2.

[0098] As described above, according to the first embodiment, display non-uniformity caused from a decrease in retention, which may easily occur due to the sealing material, is restrained, a liquid crystal display device is conveniently manufactured in an excellent yield, and a liquid crystal display device having a high reliability can be realized.

[0099] – Modified Example – Here, several modified examples of the first embodiment will be described.

[00100] (Modified Example 1) In Modified Example 1, a two surface seal pattern as shown in FIG.3 by a main seal 41 and a four surface seal pattern as shown in FIG.4 by a main seal 42 are formed respectively by a dispenser on the peripheral part of a picture display region at a glass substrate 22 side serving as a CF substrate.

[00101] On two surfaces of FIG.3, a starting point 43a and an end point 43b are linked on a substrate 22 to continuously form a seal pattern as a single overlapping portion 43, and the main seal 41 is arranged not to be overlapped on a frame pattern coupling portion. On the other hand, on four surfaces of FIG.4, a starting point 44a and an end point 44b are linked on a substrate 22 to continuously form a seal pattern as a single overlapping portion 44, and the main seal 42 is arranged not to be

overlapped on a frame pattern coupling portion. Except for this, the modified example is constructed in the same way as the first embodiment, thereby obtaining a liquid crystal display panel.

[00102] On the two surfaces of FIG.3, the starting point 43a and the end point 43b are disposed outside the frame pattern, and the main seal 41 is not overlapped on the frame pattern coupling portion, thus the main seal 41 of the frame pattern linking portion is not overlapped with a shielding film 23. On the other hand, on the four surfaces of FIG.4, the main seal 42 is overlapped on the frame pattern coupling portion, thus the seal width is increased to 2.0mm. But, this overlap is smaller than the overlapping portion between the starting point 44a and the end point 44b, and the coupling portion is a corner portion, thus the main seal 42 of the frame

pattern linking portion does not overlap with the shielding film 23.

[00103] A liquid crystal display panel manufactured using the two surfaces of FIG.3 and a liquid crystal display panel manufactured using the four surfaces of FIG.4 were provided for a lighting test. As a result, both of them show no display non-uniformity.

[00104] (Modified Example 2) A main process of Modified Example 2 will be described in FIG.5. Here, (a) represents a schematic plane view of a substrate 22a, (b) represents a schematic cross sectional view of the substrate 22a near a transfer seal, and (c) represents a schematic cross sectional view magnifying the transfer seal.

[00105] Here, an ITO film is formed by deposition on the surface of a resin spacer (eg, Micro Pearl SP manufactured by SEKISUI FINE

CHEMICAL Co., Ltd.), to thus obtain conductive particles 45. An ultraviolet curing resin used in the first embodiment is used for a transfer seal 24, and 1 wt% of the conductive particles 45 are incorporated therein. As a result of measuring the attenuation rate of ultraviolet rays acquired by the conductive particles 45 and a transparent electrode 46, the amount of light irradiated to the transfer seal 24 is smaller by 10% than the main seal 21.

[00106] Further, a reflective film 47 serving as an electrode is formed using an aluminum film at a position where the transfer seal 24 of the TFT substrate side is formed. The formation of the aluminum film is carried out along with the film formation process of the TFT. As for ultraviolet irradiation, light of an amount required for ultraviolet curing the main seal 21 is collectively irradiated from the substrate 22 side, and thereafter

ultraviolet rays formed of parallel rays are spot-irradiated to the transfer seal 24 from a vertical direction of the substrate by using a light guide 48. The amount of light for spot irradiation is almost the same (modified example 2A) as the amount of attenuation of ultraviolet rays acquired by the conductive particles 45 and the transparent electrode 46 or is 2/3 (modified example 2B) of the corresponding amount of attenuation.

[00107] Here, for comparison with the liquid crystal display device of the present example, a liquid crystal display device as shown in FIG.24 is manufactured as a comparative example. In this comparative example, conductive particles coated with nickel (eg, Micro Pearl SP manufactured by SEKISUI FINE CHEMICAL Co., Ltd.) are applied to the surface of a resin spacer, and 1 wt% thereof is incorporated in the transfer seal 106. Except

for this, the comparative example is constructed in the same way as the comparative example 1 of the first embodiment, thereby obtaining a liquid crystal display panel.

[00108] The liquid crystal display panels of the modified examples 2A and 2B and the comparative example are provided for a lighting test. As a result, while there occurs no display non-uniformity in the modified examples 2A and 2B, there occurs display non-uniformity in the comparative example from a defective hardening of a frame pattern linking portion (overlapping portion 103) and the transfer seal 106. In the modified example 2B, though the amount of light irradiated to the transfer seal 24 is insufficient, the insufficient part is filled as ultraviolet rays are reflected by the reflective film 47, whereby no display non-uniformity

caused from a detective hardening occurs.

[00109] If there is some margin between the amount of light for deteriorating liquid crystal and the amount of light for ultraviolet curing the sealing material, a reflective film can be formed on a lower part of the transfer seal 24 even without spot-irradiating ultraviolet rays to the transfer seal 24, and the transfer seal 24 can be hardened by slightly increasing the amount of light for batch irradiation.

[00110] (Modified Example 3) In the Modified Example 3, as shown in FIG.6, substrates 22a and 22b are attached to each other by hardening the sealing material to form a substrate 51. Then, thermal treatment after ultraviolet irradiation is performed by using a substrate carrier cassette 52

with a carrier arm in-and-out spacer 53 of a structure for multipoint supporting the substrate 51 surface.

[00111] As compared to this, in a comparative example, thermal treatment after ultraviolet irradiation is carried out by using a substrate carrier cassette 108 of a structure of supporting a substrate 100 at the end of a conventional substrate as shown in FIG.25.

[00112] Except for this, the modified example 3 and the comparative example are constructed in the same way as the first embodiment, thereby obtaining a liquid crystal display panel.

[00113] The liquid crystal display panels of the modified example 3 and the comparative example are provided for a lighting test. As a result, while there occurs no misalignment during thermal treatment, misalignment

occurs in the comparative example. In the modified example 3, the substrate 51 surface is multipoint-supported, thus the substrate 51 can be supported in parallel, while in the comparative example, it is supported only with the end of the substrate, the substrate 108 is bent greatly on the center, and misalignment occurs during thermal treatment.

[00114] (Second Embodiment) FIG.7 is a schematic perspective view showing ultraviolet irradiation after a liquid crystal injection process is carried out by a dropping injection method in the present embodiment, and FIG.8 is a schematic cross sectional view showing a glass substrate with the inside of circle C in FIG. 7 is magnified.

[00115] In the present example, an ultraviolet curing resin (product name: 30 Y-363 manufactured by Threebond, the amount of light for

hardening is 2500 mJ/cm^2 relative to line I), liquid crystal is injected by a dropping injection method, and thereafter a glass substrate 61 serving as a CF substrate and a glass substrate 62 serving as a TFT substrate are attached and cut to make a liquid crystal display panel. In the present example, an ultraviolet irradiation process to be carried out when attaching the glass substrates 61 and 62 is improved.

[00116] The end of an orientation film 63 on the glass substrate 61 is formed on the region where it becomes an outer side of the inner circumferential side of the corresponding resin or an inner side of the outer circumferential side thereof.

[00117] Further, for comparison, as shown in FIG.9, in a conventional example, a liquid crystal panel is manufactured, in which the end of the

orientation film 63 on the glass substrate 61 serving as a CF substrate is formed on the inner side of the inner circumferential side of the corresponding resin and a shielding mask 64 is disposed.

[00118] Ultraviolet irradiation is carried out by using a high pressure mercury lamp as a light source and arranging a blocking filter 64 transmitting almost no short wavelengths of less than 300nm and a blocking filter 65 transmitting almost no long wavelengths of greater than 500nm as shown in FIG.7.

[00119] As shown in FIG.10, the transmittance of a combination of both filters is 50% at a 313nm emission line peak, and 90% at a 365 emission line peak. The amount of ultraviolet light is 2700 mJ/cm^2 relative to line I. But, as a result of investigating non-uniformity of an irradiated region, the

amount of violet light is 2300 mJ/cm^2 at the minimum value portion of the non-uniformity and 3100 mJ/cm^2 at the maximum value portion thereof.

[00120] As a result of measuring the respective transmittances of the glass substrate and of the glass substrate with the orientation film added thereto, the glass substrate (product name: nA35/NH manufactured by Technoglass/ film thickness: 0.7mm) shows 84% at a 313nm emission line peak, and the orientation film (product name: JALS-684 manufactured by JSR Company/film thickness: 80nm) shows 71%. It is seen that the corresponding wavelength is attenuated by 15% by the orientation film.

[00121] Ultraviolet rays are irradiated to liquid crystal (product name: MJ961213 manufactured by manufactured by Merck Inc.) by using blocking filters 64 and 65 of long and short wavelengths, and the

threshold of the amount of ultraviolet light at which liquid crystal photolysis is activated is obtained from a decrease of retention. As a result, as shown in FIG.11, in a case where ultraviolet rays are irradiated through the glass substrates, the decrease of retention becomes larger when the cumulative amount of light of a wavelength band (310±20nm) near a 313nm emission line peak is about 1000 mJ/cm^2 and the cumulative amount of light thereof relative to line I is about 3000 mJ/cm^2, and the decrease of retention becomes smaller when less than these values. Further, as a result of obtaining the threshold of the amount of ultraviolet light at which liquid crystal photolysis is activated from a decrease of retention by using the blocking filter 64 of a long wavelength in the same manner, it can be seen that that value is 1000 to 1500 MJ/cm^2 relative to

line I, which is less than half the blocking filters of long and short wavelengths. This is because a long wavelength greater than 500nm is irradiated to heat liquid crystal, thereby accelerating liquid crystal photolysis caused from wavelengths of 300nm to 320nm. Therefore, it can be seen that the amount of ultraviolet light transmitting through the orientation film exceeds this value at any part of an irradiated region, thereby activating liquid crystal photolysis.

[00122] In the present example, the main seal is hardened by applying blocking filters 64 and 65 of short and long wavelengths. Meanwhile, in conventional examples, the main seal is hardened by applying only the blocking filter of a shot wavelength (conventional example 1) and applying only the blocking filter of a long wavelength (conventional example 2) and

masking the portions excepting the corresponding resin with a shielding mask. As a result of testing the lighting and displaying of a thusly manufactured liquid crystal display panel, the conventional example 2 shows display non-uniformity caused from a decrease of retention in all the circumferences near the main seal and the conventional example 2 shows display non-uniformity caused from a decrease of retention near the main seal corresponding to the maximum value portion of an irradiated region. It can be assumed that this is caused from liquid crystal photolysis using ultraviolet irradiation.

[00123] Further, in the conventional examples 1 and 2, a decrease in the retention occurs at some parts of a corner portion. Although the corner portion is attached to R (arc) so that the seal width is not increased when

applying the seal, the distance between the display region and the corresponding resin is closer than the peripheral part. In the conventional examples, the orientation film is disposed at the inner side of the inner circumferential side of the corresponding resin. Thus, if there is unhardened component, though a little, it is diffused into liquid crystal by thermal treatment and reaches near to the display region. As a result, it can be assumed that the retention has decreased at some parts of the corner portion.

[00124] Meanwhile, in the present example, the display non-uniformity caused from a decrease of retention generated in the conventional examples 1 and 2 doe not occur. This is because liquid crystal photolysis is restrained by the filters and the orientation film and the melting of

unhardened components of the corresponding resin is restrained by the orientation film.

[00125] As described above, according to the second embodiment, display non-uniformity caused from a decrease of retention, which may easily occur due to a sealing material, is restrained, a liquid crystal dropping device is conveniently manufactured at a high yield by using a dropping injection method, and a liquid crystal dropping device having a high reliability is realized.

[00126] – Modified Example – Here, a modified example of the second embodiment will be described.

[00127] In this modified example, the end of a transparent electrode and the end of an orientation film on a glass substrate 61 is formed on the

region where the ends thereof become an outer side of an inner circumferential side of the corresponding resin and an inner side of an outer circumferential side of the corresponding resin, and a liquid crystal display panel is manufactured in the same method as the second embodiment. Ultraviolet irradiation is performed in the same condition as the second embodiment except that the amount of ultraviolet light is 3200 mJ/cm^2 relative to line I. As a result of investigating non-uniformity in an irradiated region, , the amount of violet light is 2300 mJ/cm^2 at the minimum value portion of the non-uniformity and 3100 mJ/cm^2 at the maximum value portion thereof.

[00128] As a result of measuring the transmittance of the glass substrate with the transparent electrode and the orientation film added thereto, the

glass substrate shows 84% at a 313nm emission line peak, and the transparent electrode (ITO/film thickness: 80nm) and the orientation film shows 46%. It is seen that the corresponding wavelength is attenuated by 45% by the transparent film and the orientation film.

[00129] Therefore, it can be seen that the amount of ultraviolet light transmitting through the transparent electrode and the orientation film is attenuated by the transparent electrode and the orientation film even at the maximum value portion of an irradiated region, thereby inactivating liquid crystal photolysis.

[00130] As a result of providing the thusly manufactured liquid crystal display panel for a lighting and display test, display non-uniformity caused from a decrease of retention generated in the conventional

examples does not occur. Further, by increasing the amount of ultraviolet light irradiated to the corresponding resin outside the end of the transparent electrode and the orientation film, more than the amount of light for hardening is irradiated even to the minimum value portion of non-uniformity. Thus, in this modified example, the attaching strength is improved by 10% as compared to the second embodiment.

[00131] – Comparative Examples 1 and 2 – A liquid crystal display panel is manufactured in the same method as the second embodiment. Although the condition of ultraviolet irradiation is the same as the second embodiment, a high pressure mercury lamp is used as an ultraviolet irradiation light source, and a blocking filter 65 transmitting almost no

short wavelengths of less than 300nm is arranged on the glass substrate 61 side, as shown in FIG.12.

[00132] As a result of obtaining the threshold of the amount of ultraviolet light at which liquid crystal photolysis is activated from a decrease of retention by using the blocking filter 65 of a short wavelength in the same manner, it can be seen that liquid crystal photolysis is not activated even if 3000 mJ/cm^2 is irradiated relative to line I. Therefore, it can be seen that liquid crystal photolysis is not activated even if there is no filter for attenuating a wavelength of 300nm to 320nm, such as a transparent electrode film or orientation film, on the region which is an outer side of the inner circumferential side of the corresponding resin or an inner side of the outer circumferential side thereof.

[00133] As a result of providing the thusly manufactured liquid crystal display panel (comparative example 1) for a lighting and display test, display non-uniformity caused from a decrease of retention occurs on the electrode near the main seal. As a result of decomposing this panel and analyzing the liquid crystal near the main seal by a gas chromatography, resin components caused from the main seal are detected.

[00134] Furthermore, as shown in well-known examples, ultraviolet curing resin is manufactured by using a photoinitiator having an absorption spectrum at a long wavelength side of more than 320nm, and the same comparison is carried out by using the violet curing resin as a main seal. As a result of providing the thusly manufactured liquid crystal display panel (comparative example 2) for a lighting and display test,

display non-uniformity caused from a decrease of retention occurs on some parts near the main seal. As a result of decomposing this panel and analyzing the liquid crystal near the main seal by a gas chromatography, though smaller in the extent as compared to comparative example 1, resin components caused from the main seal are detected.

[00135] This is because if the corresponding resin is hardened at a long wavelength side of more than 320nm, the reaction rate of the corresponding resin is as much lowered as the energy amount is insufficient as compared to the case where a wavelength of 300 to 320nm is used. Even if an absorption spectrum of a photoinitiator is shifted to the long wavelength side of more than 320nm, it is shown that only the

absorption efficiency of energy is improved, but the reaction rate of the corresponding resin does not fall within the same extent.

[00136] (Third Embodiment) FIG.13 is a schematic perspective view of a device for dropping liquid crystal of this embodiment. This device for dropping liquid crystal comprises a dispenser 71 for discharging a predetermined amount of liquid crystal; and a measuring means 72 for measuring the amount of liquid crystal discharged by the dispenser.

[00137] The dispenser 71 discharges a predetermined amount of liquid crystal from a discharge portion of a needle shape, and drops liquid crystal inside a frame pattern formed on a glass substrate.

[00138] The measuring means 72 comprises a laser device 73, an irradiation light source, an optical sensor 74 for sensing a laser light

irradiated from the laser device 73, a data logger 75 for recording an output of the optical sensor 74 depending on time, and a computer 76 for analyzing and displaying a result of recording by the data logger 75.

[00139] In this device for dropping liquid crystal, laser light is irradiated from the laser device 73 to the liquid crystal discharged from the dispenser 71, and the result of sensing the laser light intersecting dropping liquid crystal by the optical sensor 74 is recorded by the data logger 75. At this time, the data logger 75 records, for example, an output change depending on time as shown in FIG.14. The discharge amount of liquid crystal is measured by time-integrating this output by the computer 76. The computer 76 estimates the corresponding weight based on a

written correlation between an output of the optical sensor 74 and the weight of liquid crystal.

[00140] Further, although the illustrate example shows only one optical sensor, two optical sensors may be disposed to measure the discharge amount of liquid crystal in two directions orthogonal to each other, or an additional optical sensor is disposed to measure from multilateral perspectives.

[00141] Further, the dispenser 71 may be constructed in a manner to discharge liquid crystal by moving a piston in a syringe, control the discharge amount according to a stroke of the piston, and automatically change the stroke of the piston based on the result of image processing.

[00142] As for the positional relationship between the dispenser 71 and

the optical sensor 74, as shown in FIG.15, it can be seen that since liquid drops are continuously dropped about 2cm from the liquid crystal discharge port, the discharge amount of liquid crystal is most preferably 1cm. This is because, if the discharge distance is increased to about 2cm or more by a pressure difference between the inner side and outer side of the inside of the needle or by the generation of bubbles, liquid crystal that has been continuously discharge at first becomes discontinuous, thereby reducing the accuracy of measurement.

[00143] Actually, the discharge amount was measured by using this device for dropping liquid crystal. At this time, a number of times of injection is 100,000 per second, a total amount of liquid crystal to be dropped is 250mg and the liquid crystal is dropped at 48 points, thus the

dropping amount per dropping is 5.21mg. The dispenser 71 is set to discharge this amount.

[00144] After dropping, as a result of estimating the total dropping amount from 48 number of times of output of the optical sensor 74, it was 245mg. Thus, 5mg was added by using a micro syringe. As a result of measuring the non-uniformity of the cell thickness of the thusly manufactured liquid crystal display panel, a change within about 1% was shown. In the present example, a number of times of injecting discharge liquid crystal can be increased further, thus even a dispenser having the function of repeating discharge within a short time can cope with this phenomenon.

[00145] As described above, according to the device for dropping liquid

crystal of the third embodiment, the quantity of a liquid crystal dropped in a dropping injection method can be precisely measured and controlled and the cell thickness can be made uniform by properly controlling the quantity of a liquid crystal for each dropping region, and a liquid crystal dropping injection having a high reliability can be performed at a good yield.

[00146] – Modified Example – Here, several modified examples of the third embodiment will be described.

[00147] (Modified Example 1) In Modified Example 1, as shown in FIG.16(a), a measuring means 77 is constructed to measure the discharge amount from a liquid drop shape of liquid crystal dropped in a frame pattern of a glass substrate from a dispenser 71.

[00148] The measuring means 77 comprises a CCD 78 for taking a picture of dropped liquid crystal and a computer 76 for calculating a surface area of an oblique region of liquid crystal 79 from an output of the CCD 78 as shown in FIG.16(b) and estimating the corresponding weight based on a written correlation between the corresponding surface area and the weight (volume) of liquid crystal.

[00149] Further, although the illustrated example shows only one CCD, it may be also possible to dispose a plurality of CCDs for recognize a liquid crystal shape in different directions, in order to improve the accuracy of measurement.

[00150] (Modified Example 2) In Modified Example 2, as shown in FIG.17(a), a measuring means 81 is constructed to measure the discharge

amount from a liquid drop shape of liquid crystal in the air discharged from a dispenser 71.

[00151] The measuring means 81comprises a laser device 73, an irradiation light source, an optical sensor 74 for sensing a laser light irradiated from the laser device 73, a CCD 78 for taking a picture of liquid crystal dropped in the air at a timing when the optical sensor 74 recognizes the passage of liquid crystal by the laser light, and a computer 76 for calculating a surface area of an oblique region of liquid crystal 79 from an output of the CCD 78 as shown in FIG.17(b) and estimating the corresponding weight based on a written correlation between the corresponding surface area and the weight (volume) of liquid crystal.

[00152] In this case, since a liquid crystal shape in the air can be surely

recognized by the CCD 78, it can be measured at a high accuracy without being affected by the surface shape of the glass substrate. Further, although the illustrated example shows only one CCD, it may be also possible to dispose a plurality of CCDs for recognize a liquid crystal shape in different directions, in order to improve the accuracy of measurement.

[00153] (Modified Example 3) A device for dropping liquid crystal of Modified Example 3 comprises, as shown in FIG.18(a), a metering and dropping jig 83 having a plurality of thin glass tubs 82, which is a discharge means for discharging a predetermined amount of liquid crystal from the respective thin tubes 82, and a measuring means 85 having respective backing plates 84 corresponding to the respective thin tubes

82 of the metering and dropping jig 83 and for measuring the weight of drops of liquid crystal received on these backing plates 84, wherein the drops of liquid crystal, the weight of which is measured by the measuring means and the discharge amount thereof is specified, are supplied in a manner to be dropped in the frame pattern of the glass substrate by rotating the respective backing plates 84.

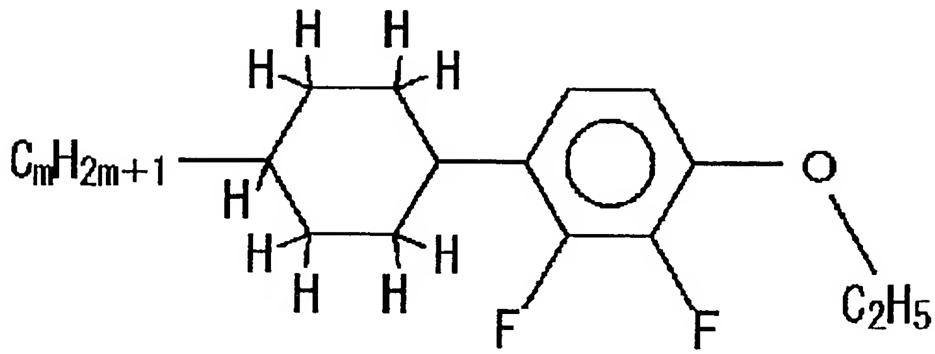
[00154] The respective thin tubes 82, as shown in FIG.18(b), is coated with Teflon (Registered Trademark) having a high water repellence on the inner surface contacted with liquid crystal, and has a structure in which liquid crystal is pushed out and discharged by a pressure of inactive gas. When dropping liquid crystal on a glass substrate, the liquid crystal often remains in the respective thin tubes 82, thus it is preferable to promote

discharge by using inactive gas. And, liquid crystal can be discharged more effectively by coating Teflon on the inner surface of the respective thin tubes 82.

[00155] (Fourth Embodiment) In this embodiment, a preferred liquid crystal material to which a liquid dropping method is applied is disclosed. The liquid crystal material of this example includes a liquid crystal compound expressed by the following general formula and the number m of carbon atoms of the end alkyl group thereof is greater than two.

[00156]

[Chemical Formula 3]



[00157] If the liquid crystal comprising a liquid crystal compound expressed by the following formula and having a number m of carbon atoms of the end alkyl group thereof of an even number is used, the specific resistance of bulk liquid crystal can be kept high.

[00158] In the present example, there are prepared a liquid crystal a having a number m of the general formula of an even number and a liquid crystal a' having a number m of the general formula of an odd number, both of them comprising a neutral component having no polar group as a common matrix. The specific resistance values of bulk liquid crystal for

the two liquid crystal materials are compared according to the following condition.

[00159] The liquid crystal comprising a neutral component having no polar group and having a number m of the general formula of an even number can obtain a good result in all of initial specific resistance, specific resistance after being left under a high temperature, and specific resistance after being exposed to ultraviolet rays (UV), as compared to liquid crystal comprising the same component and having a number m of an odd number.

[00160] Furthermore, it is preferable that the liquid crystal is restricted to the liquid crystal compounds of the general formula having a number m of 2 and 4. Generally, if the end of a liquid crystal compound is lengthened,

the liquid crystal display device is directed in a non-preferable way, including an increase of the viscosity of liquid crystal and a decrease of the response speed. The liquid crystal compound of the general formula functions to keep a wide nematic phase even when the temperature range of a mixed liquid crystal is at a low temperature side. In this case, it is preferred to include more than two kinds of compounds having a different number m as a chemical compound. Therefore, in order to restrain an increase of the viscosity of liquid crystal, it is preferable to use compounds having a number m of 2 and 4.

[00161] It is necessary to make the liquid crystal material have a low viscosity and improve the response speed of the device for dropping liquid crystal. In the dropping injection method, a vacuum left state

(including an exhaustion time) upon attaching is very short. Conventionally, the exhaustion time requiring several hours can be shortened to several minutes. Thus, conventionally, since liquid crystal volatilizes in vacuum, it is necessary to adjust the liquid crystal by a liquid crystal compound with a restrained volatility. Meanwhile, in the dropping injection method, even material with volatility can be treated for mass production.

[00162] Further, if a low viscous material that reduces the viscosity of liquid crystal is applied, the viscosity of liquid crystal can be reduced by more than 15% as compared to that before the application of viscous liquid crystal (FIG.21: liquid crystal E -> liquid crystal D). At this time, the

volatility of the liquid crystal shows a reduction (volatilization) of more than 1% in the weight ratio.

[00163] As a result of measuring the T-V property, there is no significant difference between before the application of a low viscous material and after the application thereof. Meanwhile, it is seen that the response property can be accelerated and effective by including a halftone response.

[00164] Further, from the relation with the specification of the liquid crystal display device, display characteristics, such as luminance (transmittance), response speed and so on, or mass productivity can be improved by using a liquid crystal material having a transparent point of

more than 70□, satisfying the dielectric isotropy $\Delta\varepsilon$ of $-4.0 \leq \Delta\varepsilon < 0$, and having a refractive index isotropy Δn of more than 0.1000.

[00165] Moreover, if such a liquid crystal display device has a multi-domain structure in which its liquid crystal molecules are aligned in more than two directions, the viewing angle property can be improved, thereby making the liquid crystal display device suitable for use in a liquid crystal monitor or the like.

[00166] - Experimental Example – Hereinafter, an experimental example in which a liquid crystal display device according to a fourth embodiment is manufactured and several display characteristics are investigated will be described.

[00167] (Experimental Example 1) A substrate having an ITO electrode is used, a product name JALS-684 (manufactured by JSR Company) is formed as an orientation film by a spinner, a predetermined spacer (cell thickness: 4.0μm) is applied, and they are attached by using a thermosetting sealing material, thereby manufacturing a hollow cell.

[00168] A liquid crystal A having a number m of 1 and 3 and liquid crystals B and C having a number m of 2 and 4 are injected into respective hollow cells and sealed, and a polarizing plate is attached to the liquid crystal in a cross nicol configuration, thereby manufacturing a VA cell.

[00169] As shown in FIG.20, the voltage retention, ion density, and residual DC voltage of each of cells are measured, and differences between their electrical properties are investigated. Liquid crystal A, liquid

crystal B and liquid crystal C have physical properties as shown in Table 1. Further, (a) and (b) show a voltage retention, (c) show an ion density, and (d) show a residual DC voltage. As a result of the experiment, liquid crystals B and C (number m = 2, 4) are improved in electric properties as compared to liquid crystal A (number m = 1, 3), and dependence by cumulative component is shown.

[00170]

【Table 1】 Liquid Crystal A Liquid crystal B Liquid Crystal C Liquid Crystal D Liquid Crystal E

	液晶A	液晶B	液晶C	液晶D	液晶E
NI点	71℃	72℃	73℃	72℃	70℃
Δn	0.0822	0.0826	0.0810	0.1014	0.1007
$\Delta \varepsilon$	−3.8	−3.6	−3.6	−3.5	−3.5
K_{11}	13.6	12.8	13.7	11.8	10.8
K_{33}	14.7	13.2	13.9	13.6	12.5
γ_1	135	139	142	190	157

[00171] (Experimental Example 2) The specific resistances of liquid crystals A, B and C were measured. They were investigated according to four conditions: 1) the initial value of bulk liquid crystal, 2) after UV exposure (100 mW/cm2, 60 seconds), 3) after heating (120□, 60 seconds), and after dropping UV curing resin (contamination dependence). Liquid crystals B and C (number m = 3, 4) can obtain a result superior than liquid crystal A (number m = 1, 3), especially, data after UV exposure is improved in its specific resistance by one digit.

[00172] (Experimental Example 3) A difference between liquid crystal D before the application of a low viscous material and liquid crystal E after the application thereof were investigated. The applied liquid crystal D is liquid crystal which has no problem even if a conventional vacuum deep

injection was used. Meanwhile, a low viscous material was applied to liquid crystal E, the liquid crystal has volatility to vacuum leaving.

[00173] As a result of the experiment, as shown in FIG.21, it is seen that liquid crystal E shows a change (reduction) in weight by 1% or so after one hour leaving, and has a volatility higher enough than liquid crystal D.

[00174] A VA cell was manufactured in the same order as the third embodiment except that liquid crystals D and E are used and a spacer is modified (cell thickness: 3.5μm). T-V properties are the same. As shown in FIG.22, as a result of investigating the response speed, for every applied voltage, liquid crystal E having a low viscous material applied thereto was accelerated as compared to liquid crystal D, especially, the effect of the

acceleration was large in a halftone region equivalent to a low gradation side.

[00175] As described above, according to a fourth embodiment, a liquid crystal material most suited for the dropping injection method can be provided, and thus the viscosity of the liquid crystal can be restrained so as to be low to accelerate the response speed, especially halftone response speed, and enable the improvement of the display characteristics.

[00176] Hereinafter, several aspects of the present invention will be described in appendices.

[00177] (Appendix 1) A method of manufacturing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material

to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the sealing material is applied so as to position a starting point and an end point of the sealing material application outside the frame pattern.

[00178] (Appendix 2) The method of manufacturing a liquid crystal display device of Appendix 1, wherein the sealing material is coated so as to position at least one of the starting point and the end point on an unmounted side of the substrate.

[00179] (Appendix 3) The method of manufacturing a liquid crystal display device of Appendix 2, wherein at least one of the starting point

and the end point is linked with the frame pattern so as to intersect the unmounted side.

[00180] (Appendix 4) The method of manufacturing a liquid crystal display device of Appendix 1, wherein a seal pattern is continuously formed by using the sealing material by making the starting point and the end point consistent with each other on the substrates.

[00181] (Appendix 5) A method of manufacturing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein in order to conduct the pair of substrates, ultraviolet

rays formed of parallel rays for hardening resin are spot irradiated onto a transfer seal, formed by incorporating conductive particles into resin, from a vertical direction or sloping direction of the substrate.

[00182] (Appendix 6) A method of manufacturing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein in order to conduct the pair of substrates, a transfer seal, formed by incorporating conductive particles into resin, is applied, the transfer seal is hardened by ultraviolet irradiation for attaching the substrates by hardening the resin, and the substrates are thermally

treated, being supported in parallel by a support case, after the irradiation of ultraviolet rays.

[00183] (Appendix 7) A method of manufacturing a liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the pair of substrates are conducted by a transfer seal formed by incorporating particles coated with a transparent conductive film on the surface.

[00184] (Appendix 8) A liquid crystal display device, in which a frame pattern is formed by applying a sealing material to the peripheral part of a

picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein a film for reflecting ultraviolet rays irradiated for hardening the resin is formed as an electrode on a lower part of a transfer seal for conducting the pair of substrates.

[00185] (Appendix 9) The method for manufacturing a liquid crystal display device of Appendix 8, wherein an aluminum film or silver film is used as the film for reflecting ultraviolet rays and formed on the substrate at a thin film transistor side.

[00186] (Appendix 10) A method of manufacturing a liquid crystal display device, in which a frame pattern is formed by applying a sealing

material to the peripheral part of a picture display region provided on one out of a pair of substrates, the liquid crystal is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein a liquid crystal orientation film is formed on the region where the ends thereof become an outer side of an inner circumferential side of the sealing material and an inner side of an outer circumferential side of the sealing material, light having a wavelength of about 300 to 500nm is irradiated, and the sealing material is hardened.

[00187] (Appendix 11) The method for manufacturing a liquid crystal display device of claim Appendix 10, wherein the ends of the orientation film on the substrate where at least a color filter is formed are formed on the region where the ends thereof become an outer side of an inner

circumferential side of the sealing material and an inner side of an outer circumferential side of the sealing material, light having the above wavelength is irradiated from the corresponding substrate side, and the sealing material is hardened.

[00188] (Appendix 12) The method for manufacturing a liquid crystal display device of Appendix 10 or 11, wherein a filter for blocking almost all wavelengths except for the corresponding wavelength is arranged at an irradiation light source side as a means for irradiating light having a wavelength of about 300 to 500nm.

[00189] (Appendix 13) The method for manufacturing a liquid crystal display device of one of Appendices 10 to 12, wherein the amount of light for hardening the sealing material is preferably less than about 3000

mJ/cm^2 relative to line I.

[00190] (Appendix 14) A device for dropping liquid crystal, comprising: a dispenser means for discharging a predetermine amount of liquid crystal; and a measuring means for measuring the amount of liquid crystal discharged by the dispenser means, the measuring means having an optical sensor, integrating a change in signals of the corresponding optical sensor generated when liquid discharged from the dispenser means passes through the optical sensor, and measuring the amount of liquid crystal discharged.

[00191] (Appendix 15) The device for dropping liquid crystal of Appendix 14, wherein the measuring means measures the discharge amount of liquid crystal in a manner that laser light is irradiated in a direction almost

perpendicular to discharge liquid crystal, and the output of the laser light is changed by the discharge liquid crystal intersecting this laser light to detect it by the optical sensor.

[00192] (Appendix 16) The device for dropping liquid crystal of Appendix 14 or 15, wherein the discharge amount of liquid crystal is measured in at least two directions.

[00193] (Appendix 17) The device for dropping liquid crystal of Appendix 16, wherein the discharge amount of liquid crystal is measured in two directions almost orthogonal to each other

[00194] (Appendix 18) The device for dropping liquid crystal of one of Appendices 14 to 17, wherein the optical sensor is disposed at a position within 2cm from a liquid crystal discharge port of the dispenser means.

[00195] (Appendix 19) A device for dropping liquid crystal, comprising: a dispenser means for recognizing a drop shape of liquid crystal discharged by the dispenser means and estimating the discharge amount of liquid crystal of the sealing material based on the corresponding shape.

[00196] (Appendix 20) The device for dropping liquid crystal of Appendix 19, wherein the measuring means optically recognizes the drop shape of liquid crystal, and estimates the discharge amount of liquid crystal of the sealing material from an image of the corresponding shape.

[00197] (Appendix 21) The device for dropping liquid crystal of Appendix 20, wherein the optical sensor may be disposed near a liquid crystal discharge port of the dispenser means to thus estimate the discharge amount of liquid crystal of the sealing material from the image of the drop

shape of liquid crystal by using as a trigger signal a signal of the corresponding optical sensor generated when discharged liquid crystal passes through the optical sensor.

[00198] (Appendix 22) The device for dropping liquid crystal of one of Appendices 19 to 21, wherein the dispenser means discharges liquid crystal by moving a piston in a syringe, controls the discharge amount according to a stroke of the piston, and automatically changes the stroke of the piston based on the result of the image processing.

[00199] (Appendix 23) A device for dropping liquid crystal, comprising: a discharge means having a plurality of thin tubes and for discharging a predetermined amount of liquid crystal from the respective thin tubes; and a measuring means having respective backing plates corresponding

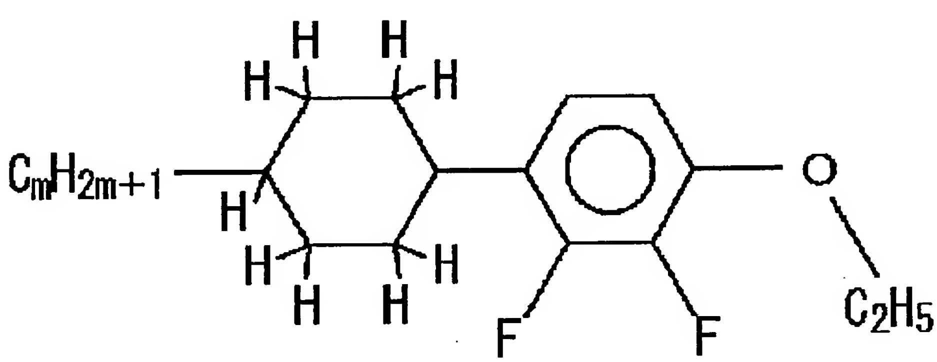
to the respective thin tubes and for measuring the weight of drops of liquid crystals received on the respective backing plates, wherein the drops of liquid crystal, the weight of which is measured by the measuring means and the discharge amount thereof is specified, are supplied from the respective backing plates.

[00200] (Appendix 24) The device for dropping liquid crystal of Appendix 23, wherein water repellent finishing for splashing liquid crystal on a liquid crystal contact region of the measuring means is performed. By this, the remaining of liquid crystal is prevented as much as possible, and a still more accurate amount of liquid crystal can be supplied.

[00201] (Appendix 25) A liquid crystal display device of a vertical orientation, which has a pair of substrates, at least one of which being

transparent, a frame pattern is formed by applying a sealing material 21 to the peripheral part of a picture display region, liquid crystal whose dielectric isotropy is negative is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the liquid crystal material comprises a liquid crystal compound expressed by the following general formula and the number m of carbon atoms of the end alkyl group thereof is greater than two.

[Chemical Formula 4]



[00202] (Appendix 26) The liquid crystal device of claim 25, wherein the

liquid crystal compound has a number m of carbon atoms of the end alkyl group thereof 2 or 4.

[00203] (Appendix 27) A liquid crystal device of a vertical orientation, which has a pair of substrates, at least one of which being transparent, a frame pattern is formed by applying a sealing material 21 to the peripheral part of a picture display region, liquid crystal whose dielectric isotropy is negative is dropped inside the frame pattern and the substrates are attached to each other, and the sealing material is hardened, wherein the liquid crystal material comprises a neutral liquid crystal compound having no polarity, and the liquid crystal comprising this neutral liquid crystal compound has a high volatility with which the weight ratio decreases by 1% or more in a vacuum state when dropped, and has a rotational

viscosity lower by 15% or more as compared to the nonvolatile neutral liquid crystal compound.

[00204] (Appendix 28) The liquid crystal device of Appendix 27, wherein the liquid crystal material has a transparent point of more than 70□, satisfies the dielectric isotropy $\Delta\varepsilon$ of $-4.0 \leq \Delta\varepsilon < 0$, and has a refractive index isotropy Δn of more than 0.1000.

[00205]

[Effect of the Invention] According to the first embodiment, to restrain display non-uniformity caused from a decrease of retention, which may easily occur due to a sealing material, manufacture a liquid crystal dropping device conveniently at a high yield by using a dropping injection method, and realizes a liquid crystal dropping device having a high

reliability.

[00206] Furthermore, it is possible to realize a device for dropping liquid crystal which performs a liquid crystal dropping injection having a good yield and a high reliability by enabling the quantity of a liquid crystal dropped in a dropping injection method to be precisely measured and controlled and making the cell thickness uniform by properly controlling the quantity of a liquid crystal for each dropping region.

[00207] Furthermore, it is possible to realize a liquid crystal display device which restrains the viscosity of the liquid crystal so as to be low by using a liquid crystal material most suited for the dropping injection method, accelerates the response speed, especially halftone response speed and improves display properties further more.

[Description of Drawings]

FIG.1 is a schematic cross sectional view showing a general main construction of a liquid crystal display device.

FIG.2 is a schematic plane view showing the shape of a glass substrate with a frame pattern formed before a liquid crystal injection process is performed by a dropping injection method.

FIG.3 is a schematic plane view showing a main construction (two surfaces) of modified example 1 of the first embodiment.

FIG.4 is a schematic plane view showing a main construction (four surfaces) of modified example 1 of the first embodiment.

FIG.5 is a schematic view showing a main process of modified example 2

of the first embodiment.

FIG.6 is a schematic perspective view showing a substrate carrier cassette of modified example 3 of the first embodiment.

FIG.7 is a schematic perspective view showing ultraviolet irradiation after a liquid crystal injection process is carried out by a dropping injection method in a second embodiment.

FIG.8 is a schematic cross sectional view showing a glass substrate with the inside of circle C in FIG. 7 is magnified.

FIG.9 is a schematic perspective view showing comparative examples of the second embodiment.

FIG.10 is a characteristic view showing the wavelength dependence of transmittance.

FIG.11 is a characteristic view showing the photolysis reaction of liquid crystal.

FIG.12 is a schematic perspective view showing comparative examples 1 and 2 of the second embodiment.

FIG.13 is a schematic perspective view of a device for dropping liquid crystal of a third embodiment.

FIG.14 is a characteristic view showing an output change depending on the time of an optical sensor.

FIG.15 is a schematic block diagram showing the positional relationship between a dispenser and the optical sensor.

FIG.16 is a schematic block diagram showing modified example 1 of the device for dropping liquid crystal of the third embodiment.

FIG.17 is a schematic block diagram showing modified example 2 of the device for dropping liquid crystal of the third embodiment.

FIG.18 is a schematic block diagram showing modified example 3 of the device for dropping liquid crystal of the third embodiment.

FIG.19 is a characteristic view showing the initial specific resistance of liquid crystal material, the specific resistance after a high temperature leaving, and the specific resistance after UV exposure in a fourth embodiment.

FIG.20 is a characteristic view showing the result of measuring the voltage retention, ion density and residual DC voltage of each of cells in experimental example 3.

FIG.21 is a characteristic view showing the result of investigating a

difference in volatility between liquid crystal before the application of a low viscous material and liquid crystal after the application thereof.

FIG.22 is a characteristic view showing the result of investigating a difference in acceleration between liquid crystal before the application of a low viscous material and liquid crystal after the application thereof.

FIG.23 is a schematic view for explaining problems about a sealing material in the prior art.

FIG.24 is a schematic view for explaining problems about the sealing material in the prior art.

FIG.25 is a schematic view for explaining problems about the sealing material in the prior art.

FIG.26 is a schematic view for explaining problems about the sealing

material in the prior art.

FIG.27 is a schematic view for explaining problems about the sealing material in the prior art.

FIG.28 is a schematic view for explaining problems about the sealing material in the prior art.

[Description of Reference Numerals]

1, 2, 22	glass substrate
21, 41, 42	main seal
23	shielding film
24	transfer seal
31, 44	overlapping portion
31a	starting point

31b	ending point
45	conductive particles
46	transparent electrode
47	reflective film
52	substrate carrier cassette
64	blocking filter for short wavelengths less than 300nm
65	blocking filter for long wavelengths of 500nm or less
71	dispenser
72, 77, 85	measuring means
73	laser device
74	optical sensor
75	data logger

76 computer

78 CCD

82 thin glass tube

83 metering and dropping jig

84 backing plate